Coulomb distortion of π^+/π^- as a tool to determine the fireball radius in central high energy heavy ion collisions *

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In this work, we computed the Coulomb distortion produced by an expanding and highly charged fireball on the spectra of low transverse momenta and mid rapidity pions produced in central high energy heavy ion collisions.

An important feature to account for in the analysis of the spectra of secondaries produced in the collision of heavy systems is the presence of a large amount of electric charge. Due to the long-range nature of the electromagnetic interaction, the spectrum of charged particles will be distorted even after freeze-out. For central collisions, this Coulomb effect can be more significant when there is strong stopping and the participant charge in the central rapidity region is an important fraction of the initial charge.

Another feature to consider is that the field-producing charge distribution is in general not static but rather participates in the dynamics responsible for matter expansion after the collision. The combined role played by Coulomb distortions and expansion in the description of charged particle spectra has been the subject of some recent work. In this work, we focused on the description of Coulomb effects on pion spectra from a spherically symmetric expanding source. We then compared our calculation to mid-rapidity pions produced in central Au+Au reactions at 11.6A GeV from E866 at the BNL AGS and in central Pb+Pb reactions at 158A GeV from NA44 at the CERN SPS.

Our work is based on the following Vlasov equation which describes the motion of the test charges

$$\left[\frac{\partial}{\partial t} + \frac{\mathbf{p}}{E_p}\cdot\nabla_r \pm e\mathbf{E}(\mathbf{r},t)\cdot\nabla_p\right] f^{\pm}(\mathbf{r},\mathbf{p},t) = 0$$

with the Electric field given by the spherically expanding charged fireball. The solution is found by the method of characteristics. This involves solving the classical equations of motion and using the solutions to evolve the initial distribution, taken to be a thermal distribution. To determine the value of the surface expansion velocity, we match the average transverse momentum, as inferred from our assumption of a uniformly expanding sphere, with the measured one. For central Pb+Pb collisions at 158A GeV, we take as the effective fireball's charge $Z = 120$. To model the primordial distribution, we use an exponential parametrization of dN/p^2dp from which we extract an effective temperature $T_{eff} =$ 110 MeV up to $m_T - m = 500$ MeV. The best fit to the π^+/π^- ratio, shown in the following figure, is obtained for a value of the freeze-out radius for pions of 10 fm with a $\chi^2_{p.d.o.f.} = 1.67$.

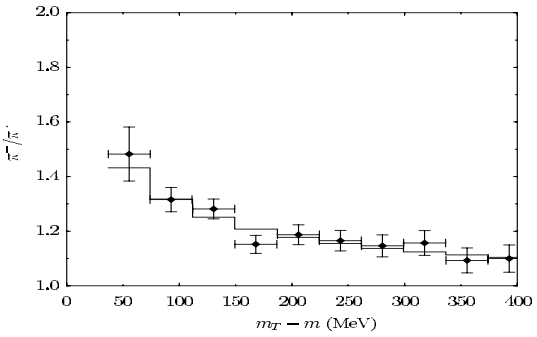

Figure 1: The ratio π^-/π^+ vs. $m_T - m$ at the AGS. The data is from E866. The fireball radius at pion freeze-out is 10 fm.

Footnotes and References

*LBNL #: Proceedings, 14th International Conference on Ultrarelativistic Nucleus-Nucleus Collisions (QM 99), Torino, Italy, May 1999. Presented by A. Ayala. e-Print Archive: hep-ph/9908259

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